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Ferromagnetism and Superconductivity in pure and doped $RuSr_2GdCu_2O_8$*

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The "ferromagnetic" superconductors $Ru(La_xSr_{1-x})_2GdCu_2O_8$ and $RuSr_2Eu(Zn_xCu_{1-x})_2O_8$ are systematically investigated as a function of doping level, of temperature and of external magnetic field.
These compounds are characterized by superconductivity (T_C = 45 K) in the CuO_2 planes coexisting with weak ferromagnetism in the RuO_2 planes. Pure Ru1212 reveals properties similar to those observed in heavily underdoped high-Tc materials.
The doping experiments lead to a reduction of the charge carrier density and already at x = 0.03 superconductivity is completely suppressed. In the case of La doping without significant structural changes the magnetic ordering temperatures are slightly enhanced. On increasing x the charge carriers are localized at low temperatures and for $x = 0.1$ semiconducting transport properties dominate below room temperature.
We show detailed examinations of transport, magnetization and caloric properties. In addition the magnetic AC-susceptibility was extensively analyzed and results from microwave and optical conductivity measurements in the far-infrared are presented.

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